THE INVERTEBRATE CAVE FAUNA OF KENTUCKY AND ADJOINING STATES.

BY A. S. PACKARD, JR.

I. ARANEINA.

In an article on the insects and crustaceans of Mammoth Cave, based on specimens obtained by Messrs. F. W. Putnam and C. Cooke, published in 1871 (American Naturalist, vol. 5), I expressed the hope that thorough zoological explorations of Mammoth Cave would be made by a state commission or by persons acting under the authority of the state. This hope has been fully realized. Since the publication of the "Mammoth Cave and its Inhabitants,"[1] the new geological survey of Kentucky has been instituted, under the charge of Prof. N. S. Shaler, who invited Mr. Putnam and myself to explore the caves of Kentucky under the auspices of the survey. Accordingly, during portions of the months of April and May, 1874, I examined Mammoth Cave and several adjoining, *i. e.*, White's Cave, Dixon Cave, Diamond Cave and Proctor's Cave, in company with Prof. Shaler and Mr. F. G. Sanborn, assistant on the survey, and subsequently Mr. Sanborn explored these and Carter caves. In company with Prof. Shaler, I also made a slight examination of the four Carter caves. Fully appreciating the importance of the subject of cavern life and of comparing the fauna of different caves, Prof. Shaler invited me to visit Wyandotte Cave, and the Bradford caves in Indiana. The Bradford caves I visited in company with Dr. John Sloan, of New Albany, Ind., who had already examined, with much success, many of the small caverns in southern Indiana. His observations on the temperatures of the caverns of his state are of much interest, and will be published in a succeeding paper. The collections made by him and contained in the Museum of Natural History of New Albany were also examined, and he has kindly sent me other material. On my return I examined Weyer's Cave and adjoining Cave of the Fountains near Staunton, Virginia, and discovered about twenty forms, where before none were known to inhabit

[1] By A. S. Packard, Jr. and F. W. Putnam, 8vo. pp. 62. With two plates and cuts. Salem, 1872.

those caves. In the autumn Mr. Putnam made a thorough exploration of Mammoth Cave. These papers are accordingly based on material collected by him, Prof. Shaler, Mr. Sanborn, Mr. Cooke, Dr. Sloan and myself.

Mr. Emerton kindly identified and described the spiders of the caves, and his paper and drawings accompany this article. The Coleoptera have been identified by Dr. LeConte, the Diptera by Baron Osten Sacken, and the only Neuropterous insect found, an immature Psocus, has been figured and identified, so far as it could be, by Dr. Hagen.

Without at this time speaking of the physical aspects of the caves, I may say that the life of the caverns is much more abundant than I had supposed from the accounts given by others. The spiders were found not infrequently in all the caverns mentioned in the notes appended to Mr. Emerton's descriptions. I should say that the spiders were equally abundant in Mammoth and Wyandotte caves, but they were most abundant in Weyer's, where three species occurred They were next commonest in the Carter caves. These are small caverns, none more than a mile in extent; but it is interesting to observe that in Mammoth and Wyandotte caves respectively, both between five and seven or eight miles in extent, so far as rude measurements show, there was but a single species. The following table shows the distribution of the six species of true cave spiders:

MAMMOTH.	WYANDOTTE	BRADFORD.	CARTER.	WEYER'S.
Anthrobia mammouthia	Linyphia subterranea	?NesticusCarteri.	Nesticus Carteri.	Nesticus pallidus.
			Linyphia subterranea.	Linyphia Weyeri.
			Linyphia incerta.	Linyphia incerta.

It will be seen that the two largest and consequently most ancient caverns, Mammoth and Wyandotte, and in which the physical environment of the species is most unvarying, have but one species each. The *Anthrobia mammouthia* is only found in Mammoth, and the small caverns, *i. e.*, Diamond and Proctor's, situated about five miles from it. No other species occurred in these smaller caves. The only spider found in Wyandotte Cave was the *Linyphia subterranea*, which also occurred in the Carter caves,

while in the Bradford Cave occurred a Nesticus thought by Mr. Emerton to be identical with *Nesticus Carteri*. The Carter caves and Weyer's caves are small caverns, all perhaps less than half a mile in length, with the exception of Bat Cave which is perhaps over a mile in length; the distances are uncertain, these caverns winding about very irregularly and their length is only estimated by guesswork.

It is in the small caverns of Carter County, Kentucky, and the two Weyer's caves (Weyer's and the adjoining Cave of the Fountains) which are often but a few (less perhaps than a hundred) feet below the surface, that the variation and number of species is greatest. In each set of caves there are three species, to one in Mammoth and Wyandotte caves. The individual variation was the greatest in *Nesticus pallidus*, and, as might be suspected, in the eyes. The degree of variation is indicated in Mr. Emerton's description.

The spiders occurred more abundantly in all the caves than we expected. The individual abundance was greater in the smaller caverns, especially the Weyer's caves, than any others. In the Mammoth Cave the Anthrobia occurred under stones in dry but not the driest places, on the bottom at different points in the cave. Sometimes two or three cocoons would be found under a stone as large as a man's head. The cocoons were orbicular, flattened, an eighth of an inch in diameter, and formed of fine silk, and contained from two to five eggs. They occurred with eggs in which the blastodermic cells were just formed, April 25th. The eggs were few in number and seemed large for so small a spider, being $\frac{25}{1000}$ inch in diameter. The chorion is very thin, and finely speckled. The blastodermic cells seemed very large, the largest measuring nearly $\frac{4}{1000}$ inch in diameter. They were round, not closely packed and showing no indications of being polygonal. They all had a dark, very distinct nucleus. I was unable to trace the development of the young, and ascertain if the embryos are provided with rudimentary eyes. Two young *Anthrobiæ* hatched out May 3d in my room. The whole body, including the legs is snow white, with the legs much shorter than in the adult. The adult in life is white, tinged with a very faint flesh color, with the abdomen reddish, in some specimens the abdomen has beneath several large transverse dusky bands. The *Linyphia subterranea*, as observed living in Wyandotte Cave, is pale pinkish horn-brown on the thorax and legs, while the abdomen is dull honey-yellow.

What constitutes the food of these diminutive, weak, sedentary spiders, I cannot conjecture, unless it be certain minute delicate mites or young Poduræ. They spin no web, though some of the spiders in Weyer's Cave (Cave of the Fountains) do spin a weak, irregular web, consisting of a few threads. The Sciaræ and Chironomus are too large and bulky to be captured by them. The probable insufficiency of food as well as light, may account for their small size and feeble reproductive powers. The individuals were far less numerous than those of the Acanthocheir and Chelifers.

The distribution of Cave Araneina in the middle states, is paralleled by that of the other insects, as we shall see in subsequent papers. The other Arachnidans follow much the same law. So with the Myriopods. The *Spirostrephon* (Scoterpes) *cavernarum*, of Wyandotte Cave occurs abundantly in the Carter caves, but not in Mammoth Cave, which is so much nearer Wyandotte Cave. The common myriopod of Weyer's Cave, on the other hand, is closely allied to *Spirostrephon Copei*, but much less hairy.

I may here anticipate a fact which I shall bring out more fully in a subsequent paper and which has an important bearing on the derivative theory. I found in the Carter caves several specimens of *S. cavernarum* which were reddish-brown, and had apparently larger eyes than the normal white examples characteristic of the Carter and Wyandotte caves. I regard it as extremely probable that this reddish race has not been established long enough in the cavern to lose its original brown color. We here see, in fact, a cave species in process of formation, and I regard this as one of several facts which I hope to offer in subsequent papers, tending to prove that nearly all the cave animals are modified forms living at the present day out of doors. In all the caves examined, except Mammoth and Wyandotte, living Pulmonate mollusks occurred. The large dead snail shells I found on the banks of the river Styx in Mammoth Cave, must have been carried in dead by floods from the Green River or through fissures from above.

Every vegetable was carefully preserved. The common plant found in Mammoth Cave has been identified by Prof. Farlow as the old *Byssus aurantiaca*, now known under the name of *Ozonium auricomum* Link. Prof. Farlow, who kindly identified the cave plants, says that it is "found in caves on wood in Great Britain, Germany, etc., and has been found in Michigan and elsewhere by Schweinitz. As far as I know it is simply the mycelium of some

unknown fungus." A young Peziza occurred in Weyer's Cave, it was not in fruit, was colorless, and impossible to determine specifically. A colorless Agaric also occurred in Weyer's Cave.

The temperature of Weyer's Cave on May 18th, was 55°–56° Fahr. for both water and air; that of Zwingle's and Bat Cave (Carter caves) was ascertained by Prof. Shaler to be 48° for the water. Dr. Sloan ascertained the temperature of the brook in Bradford Cave to be 55° on May 9th. The temperature of Mammoth Cave is 59° the year around, according to Prof. B. Silliman. Mr. H. W. Conrad, proprietor of Wyandotte Cave, informs me that the temperature of Wyandotte Cave varies from 54° to 57° F.; that of Little Wyandotte Cave in April is 50°.

NOTES ON SPIDERS FROM CAVES IN KENTUCKY, VIRGINIA AND INDIANA.

BY J. H. EMERTON.

THE collection of cave spiders contained about one hundred specimens of eleven species. Two species were found only about the mouths of caves. These are *Theridion vulgare* Hentz, a spider found all over the country in shady places, and a large species of Meta, which has been found in similar situations in Massachusetts and New Hampshire, and resembles *Epeira fusca* Blackwall. One young spider allied to Tegenaria was taken in Fountain Cave, Virginia, and four specimens of a species of the same family were found in small caves in Carter county, Kentucky; all were immature except one female, and none showed any subterranean characters. The remaining six species, all belonging to the *Theridiidæ*, were found in considerable numbers in the larger caves where there is little or no light and the climate is little affected by outside changes. One species of Linyphia from Weyer's Cave, Virginia, has the eyes of the normal size and number, and the colors and markings of some specimens are as bright as on spiders of the same family living in cellars or shady woods. The other five species are all pale in color and show some unusual condition of the eyes, three species having the front middle pair very small, one having all the eyes small and colorless,